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Art. XVI.—*The Eastern Boundary of the Bendigo Gold-field.*

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Introduction.

The existence east of Bendigo of beds higher than those of the central or gold-fields area has long been known, or at any rate surmised. E. J. Dunn(1) gave a geological plan on which a central "favorable area" is shown surrounded by a "No. 2 area" of overlying rocks, and outside this a still higher "No. 3 area, either non-auriferous or but slightly so." Herman(2) criticized Dunn's interpretation of the structure of the field, and showed, incidentally, that portions of the No. 3 area are lower, not higher, than the central portion.

In 1924, A. T. Woodward (*vide* Harris(3)) discovered Darriwilian graptolites east of Bendigo, and I was led to examine the area in some detail. It was at once evident that at one point at least the boundary between Dunn's No. 2 and No. 3 areas east of Bendigo marked an important stratigraphical break, and an attempt was made to obtain further information north and south of this point. Several successful traverses were made, enabling a boundary line to be plotted for a distance of about 14 miles. It is possible that further work may extend this.

In this work I received every encouragement from Mr. W. Baragwanath, Secretary for Mines, and assistance from the Bendigo Branch of the Geological Survey, then in charge of the late Mr. H. S. Whitelaw. While my work was in progress, Mr. J. Caldwell, of the Survey staff, was engaged on an area which included part of the district that I was studying. His work enabled a more comprehensive account of the structure of the whole district to be given, and in the portion nearer to Bendigo, with which I was mainly concerned, it served as a check on my earlier observations, except in one of the described sections, where Mr. Caldwell's mapping fills in an important gap in my records. I had the opportunity of visiting many parts of the district with Mr. Caldwell, identifying the numerous graptolites he collected and indicating the zones represented.

In addition, I have had on many occasions the pleasure of the company in the field of Messrs. P. Tilson, of the Echuca Technical School, and D. E. Thomas, of the Geological Survey of Victoria.

Traverses across the Boundary.

(*a*) *Emu Creek Water Race.*

The most southerly observations were made in the south-west of the Parish of Strathfieldsaye. Here the meanders of the Emu Creek No. 2 water race of the Victorian Water Supply Commission expose numerous graptolite beds. The only part relevant to the present discussion is that between the Emu Creek Church of England (allotment 30B of section III.) and the south-west corner of the parish. From the church southward the race cuts through almost continuously fossiliferous beds till it reaches the boundary of the State forest. These beds all belong to the upper part of the Darriwilian, but a troublesome cleavage makes an exact account of their fauna difficult. As the race is followed southwestward the last Darriwilian outcrop occurs near a series of low brick falls in the race. Then upstream for about 20 chains one crosses a flat with no rock exposures. When rock again appears in the channel walls it is no longer soft-pink or purple crushed shales, but hard brown or greenish micaceous shales and sandstones. Lithologically these beds would be placed lower, and this is corroborated by the finding of a solitary specimen of *Tetragraptus fruticosus* (4-br) about half a mile west of the falls. The brown shales and sandstones continue, and in the extreme south-west of the parish Bendigonian beds can be recognized with certainty, *Tetragraptus fruticosus* (3-br) and *Phyllograptus* being found.

(*b*) *West of Strathfieldsaye Township.*

This section is a short distance to the north of the one just described, and for it I am indebted to the work of J. Caldwell, which I quote with the permission of the Secretary for Mines. On the western boundary of the Parish of Strathfieldsaye, about 1½ miles from the north-west corner, Upper Darriwilian graptolites occur in broken material thrown out from shallow alluvial shafts. They can be traced to the eastward, and one of the best exposures is the surfaced area near the north-west corner of allotment 3 of section XIX., marked A196 on Caldwell's plan. Less than 60 chains to the south, and, therefore, much closer across the dividing line, running a little to the west of north, Lancefieldian graptolites (*Bryograptus*) occur. Similar fossils are found further south, and again Upper Darriwilian graptolites occur within a mile to the east of them. The actual line of demarcation passes across soil-covered flats, but its general direction is obvious. Still further south, in allotments 5 and 6 of section IV., Caldwell has found Bendigonian graptolites, showing that the Lancefieldian belt is narrow and about half a mile wide. My own observations lead me to believe that it narrows still further

as it is traced south, but the evidence of a single *Tetragraptus fruticosus* found in situ along the Emu Creek race is insufficient to warrant a definite statement.

Fig. 1.

(*c*) *McIvor-road and Heathcote Railway* (*Fig.* 1).

The McIvor-road leads east from Bendigo towards Axedale and Heathcote, and, like the Mount Alexander-road further south, preserves the name of the once famous gold diggings, on which the township of Heathcote arose. For its whole length it is closely followed by the railway, so that road and railway give practically the same section. Leaving the closely settled

city area of Bendigo, one goes eastward over rising ground along the slopes of which runs a water race shown on old maps as the "Spring Gully Aqueduct." Along this race and east of it Lancefieldian graptolites may be gathered, including *Tetragraptus approximatus* and *T. decipiens*. The rocks are predominantly brown sandstones and shales, the latter with the somewhat satiny gloss often characteristic of the older beds. Further east, graptolites are hard to find, but a few distinct forms were discovered north-west and east of the Grassy Flat Reservoir No. 2. North of this, the road passes through a cutting which, though shallow, fortunately shows a continuous section along the south side of the road. When the road cutting ends the section is continued by a storm-water channel. With breaks, the channel and the railway cuttings carry the section eastward for 3 miles. This is the most satisfactory section in the district. The brown shales just mentioned are not fossiliferous in their most easterly extension, but can be traced westward to Lancefieldian graptolite beds as already stated. Their dip is uniformly to the east, and they end abruptly, being succeeded on the road by 10 feet or so of ferruginous rubble, immediately east of which is a thin band of flinty quartz fragments, probably representing as nearly as can be determined the actual break in the country. Then come crushed and slickensided soft pink and purple shales, in the fragments of which, even close to the break, fragments of graptolites can be distinguished. As these shales become less shattered, they are seen to be richly fossiliferous, and for over a mile and a half every favorable band—some of considerable width—yields nothing but high Darriwilian (D 1) graptolites in the profusion so characteristic of this horizon. To complete the section, it may be stated that the highest beds pass through transition beds to D 2 and then to D 4, a bed repeated after a considerable interval. Still further east the beds descend through the Castlemainian to Bendigonian and Lancefieldian.

(d) White Hills and Epsom.

North of the McIvor-road section is an area of country unfavorable for detailed work, but the continuation of the line was picked up just north of the Bendigo city area. The bedrock, where exposed in the railway cuttings at White Hills, is almost certainly not Darriwilian, but just outside the city boundary the characteristic blue and purple shales are shown among the debris from old alluvial shafts, now filled in, between the Echuca road and the railway. Across the Bendigo Creek to the west is the old spoil heap of a mine on the Isabella Reef. The change in the nature of the sediments is most striking. The alluvial shafts yield, from material weathered almost to clay, the characteristic D 1 forms. The brown shales of the reef mine are unfossiliferous, but after an intensive search *Tetragraptus decipiens, Clonograptus, Bryograptus*, and Phyllocarids were

found in thin black partings, demonstrating the Lancefieldian age of the beds. The distance between these two beds is about half a mile, but the line is even more closely marked by the finding of Darriwilian graptolites in or near allotment 46 of Epsom.

(*e*) *Huntly.*

As one works north from Bendigo, the relief of the area becomes less pronounced, and rock outcrops are less frequent. Where shales do occur, they are often so bleached that all traces of graptolites are obliterated. The Bendigo Creek also meanders here through wide silted flats. Fortunately, the course of the Huntly Deep Lead is more or less coincident with the valley of the Bendigo Creek, and numerous spoil heaps show the typical pink and purple shales. Badly weathered as is the material it rarely disappoints the searcher for fossils, provided he is indifferent as to state of preservation. The lower or Lancefieldian rocks provide a marked contrast, but fortunately graptolites, though very rare, are not entirely absent. The most northern line of section was run west from Huntly township. At the Huntly Railway Station, and just north of the township, lower and middle Darriwilian graptolites may be obtained from numerous bands (D 5-D 3). Southwest of the township, in allotment 8 of section XXIX., higher beds occur (probably D 2-D 1), and the occurrence in close proximity of slabs, some of which split along the bedding and some almost at right angles to it, would seem to indicate that the beds are closely folded. Still further west, W. Kingston, of the Bendigo Geological Survey Office, collected typical D 1 graptolites, while from thin partings of ferruginous shale near the Wallace Reef I was fortunate enough to collect *Clonograptus* and *Bryograptus*, indicating that as far north as this the Lancefieldian abuts on the Upper Darriwilian.

This last locality is just on the edge of the "Whipstick" or Mallee belt, into which the beds have not yet been traced.

Summary of the Evidence of the Sections.

When the results of the above five sections are plotted on the map (Fig. 2), it is seen that the dividing line between high Darriwilian beds to the east and Lancefieldian beds to the west (possibly Bendigonian in the south-west) is an almost straight line bearing about N. 15° W. and traceable for 14 miles or more. Evidence from the Bendigo area on the west and the Axedale area on the east shows that Bendigonian and Castlemainian beds were deposited throughout the whole district, and that the succession is normal. Herman's estimate (pp. 12-13), based on the palaeontological work of R. A. Keble, gives the thickness of the incomplete Castlemainian in the Bendigo area as 3,300 feet

measured vertically, but the evidence for this cannot be regarded as conclusive. Herman's estimate (also based on Keble's work) for the thickness of the Bendigonian vertically is 5,400 feet, and may be accepted as being as nearly accurate as the weighing of a considerable amount of evidence by the palaeontologist best acquainted with these beds would permit. The thickness of the Darriwilian east of Strathfieldsaye has not been measured, but may perhaps be taken as being as great as that given above for the Castlemainian. Assuming these thicknesses, and knowing that the highest Darriwilian abuts on beds which are almost certainly not the highest of the Lancefieldian, the thickness of missing beds would appear to be over 12,000 feet measured vertically, or perhaps 5,000 feet measured at right angles to the dip. The only practicable explanation of this seems to be faulting, and I would suggest the name "Whitelaw Fault" for the feature, perpetuating the name of a family whose work on Victorian gold-fields was outstanding, and particularly of the late H. S. Whitelaw, who was, at my request, the first to show any portion of the fault line on a plan. The direction of the fault is practically that of the strike of the rocks.

Comparison with Dunn's plan shows that while at first sight it appeared that the fault coincided with his boundary, this was due only to the fact that the fault was first noted at the only point where there was any coincidence—on the McIvor-road. North and south of this, Dunn's line and the fault do not approach each other.

The most striking comparison is with the Muckleford Fault described by Harris and Thomas(4). This, like the Whitelaw Fault, has a direction practically coincident with the strike of the bedrock, and separates Lancefieldian beds on the west from Darriwilian on the east, though the Darriwilian beds east of Bendigo are higher than those along the Muckleford Fault. In both cases the line is important as separating an area in which reef gold-mining has been successfully carried on from one in which no great discoveries have been made.

References.

1. Dunn, E. J. Reports on the Bendigo Gold-field, Pts. I. and II. Special Reports, Dept. of Mines, Victoria, 1893, 1896.

2. Herman, H. Structure of the Bendigo Gold-field. *Bull. Geol. Surv. Vic.*, No. 47, 1923.

3. Harris, W. J. Victorian Graptolites, Part 2. *Proc. Roy. Soc. Vic.* (n.s.), xxxviii., 1926.

4. Harris, W. J., and Thomas, D. E., Geological Structure of the Lower Ordovician Rocks of Eastern Talbot. *Ibid.*, xlvi. (2), 1934.

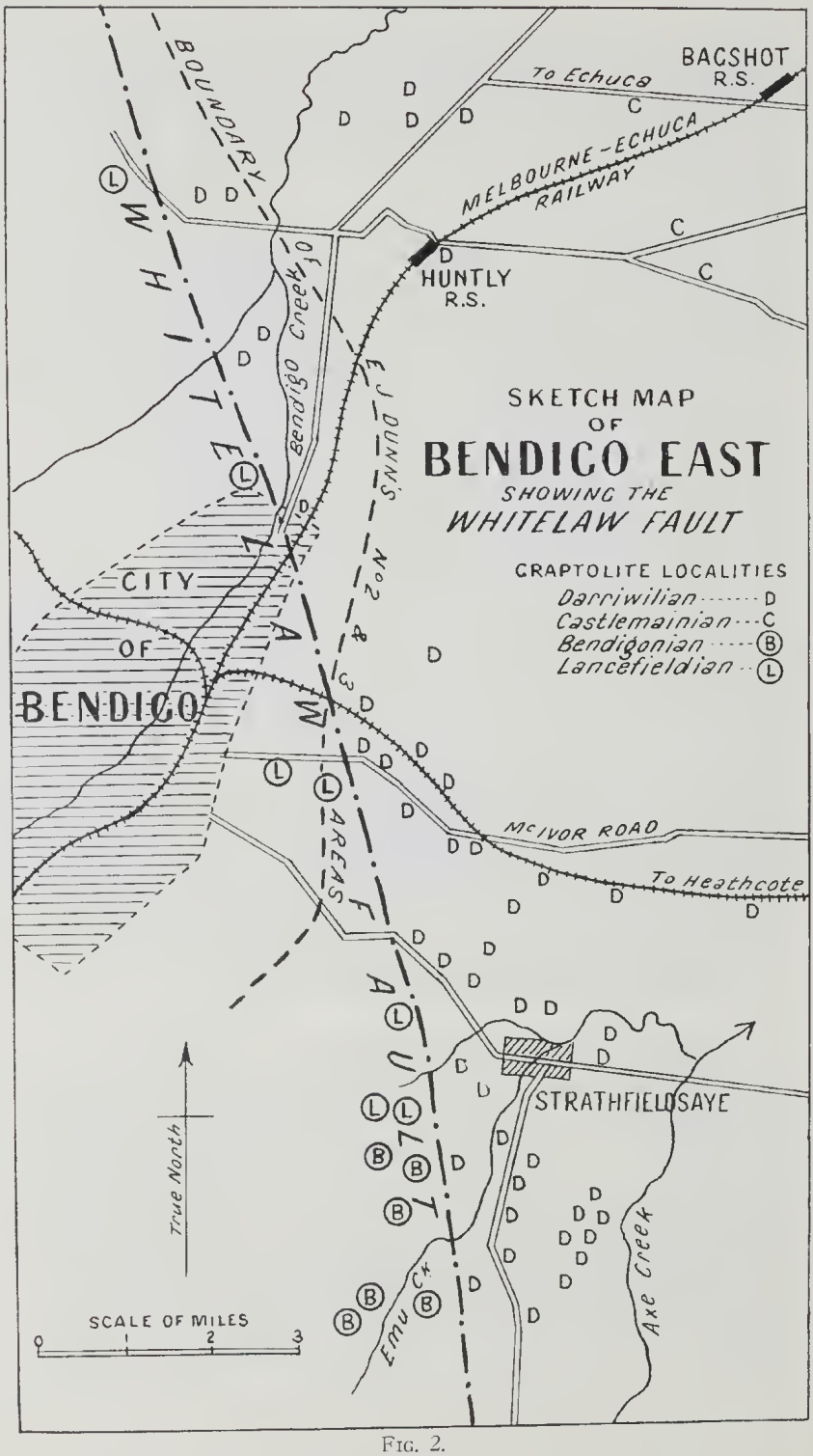
BOUNDARY
WHITELAW FAULT
BACSHOT R.S.
To Echuca
MELBOURNE-ECHUCA RAILWAY
HUNTLY R.S.
Bendigo Creek
EJ DUNN'S No 2 & 3
SKETCH MAP OF
BENDICO EAST
SHOWING THE
WHITELAW FAULT
GRAPTOLITE LOCALITIES
Darriwilian ..... D
Castlemainian ... C
Bendigonian ..... B
Lancefieldian .. L
CITY OF BENDICO
McIVOR ROAD
To Heathcote
AXE CREEK FAULT
STRATHFIELDSAYE
True North
SCALE OF MILES
0 1 2 3
Emu Ck
Axe Creek

Fig. 2.